Computer Organization (0306-550) - Winter 2012
Homework Assignment #3 - Due Thursday January 10

1. **You are to add support for the jr (jump register) MIPS instruction to the MIPS single-cycle datapath of 4rd Edition figure 4.17 page 322 (3rd Edition figure 5.17 page 307).**

a) **Add necessary datapath components, connections, and control signals to support this instruction. Justify the need for the modifications.**

b) **Specify control line values for this instruction by adding a new row for jr to the control table in 4rd Edition Figure 4.18 page 323 (3rd Edition Figure 5.18 page 308, lecture 4 slide 46).**

2. **You are to add support for a new instruction l_inc (load increment) to the MIPS single-cycle datapath of 4rd Edition figure 4.17 page 322 (3rd Edition figure 5.17 page 307). The l_inc instruction is a variant of lw (load word) which increments the base address register after loading from memory. This instruction (l_inc) corresponds to the following two instructions:**

```
lw $rt, L($rs)
addi $rs, $rs, 4
```

Where L is just the usual offset. You may assume that register specifiers $rs,$rt do not refer to the same register.

a) **Add necessary datapath components, connections, and control signals to support this instruction. Justify the need for the modifications.**

b) **Specify control line values for this instruction by adding a new row for l_inc to the control table in 4rd Edition Figure 4.18 page 323 (3rd Edition Figure 5.18 page 308, lecture 4 slide 46).**

c) **Explain why it is not possible to modify the single-cycle datapath to support the l_inc instruction without modifying the register file.**

The MIPS single-cycle datapath referred to in questions 1 and 2 above is the one without jump support (Lecture 4, slide 39)

3. **You are to add support for the lui (load upper immediate) MIPS instruction to the MIPS multicycle datapath of 3rd Edition Figure 5.28 page 323 (see handout). Provide a solution that completes this instruction in 3 cycles.**

a) **Add necessary datapath components, connections, and control signals to support this instruction. Justify the need for the modifications.**

b) **Show the necessary modifications to the multicycle control finite state machine of 3rd Edition Figure 5.37 page 338 (see handout) to support the lui instruction. In addition to relevant control line values, you must provide dependant RTN statements for each state you add.**

4. **You are to add support for a new instruction ldi (load immediate) to the MIPS multicycle datapath of 3rd Edition Figure 5.28 page 323 (see handout). This instruction (ldi) loads a 32-bit immediate value from the memory location following the instruction into register rt.**

a) **Add necessary datapath components, connections, and control signals to support this instruction. Justify the need for the modifications.**

b) **Show the necessary modifications to the multicycle control finite state machine of 3rd Edition Figure 5.37 page 338 (see handout) to support the ldi instruction. In addition to relevant control line values, you must provide dependant RTN statements for each state you add.**

5. **Consider a change to the MIPS multicycle datapath that alters the register file so that it has only one read port.**

a) **Describe and also illustrate (via a diagram) any additional changes that will need to be made to the datapath in 3rd Edition Figure 5.28 page 323 (see handout) in order to support this modification.**

b) **Modify the finite state machine (3rd Edition Figure 5.37 page 338 - see handout) to indicate how the instructions will work given the modified datapath.**

You can photocopy the figures or use versions from lecture notes to make it faster to show needed modifications